Assessing the Potential Effects of Climate Change on Sumter National Forest

Forestlands across the region are experiencing increased threats from fire, insect and plant invasions, disease, extreme weather, and drought. Scientists project increases in temperature and changes in rainfall patterns that can make these threats occur more often, with more intensity, and/or for longer durations. Although many of the effects of future changes are negative, natural resource management can help mitigate these impacts. Responses informed by the best current science enable natural resource professionals within the Forest Service to better protect the land and resources and conserve the region's forestlands into the future.

Forest Health - Invasive and aggressive plant and insect species may increasingly outcompete or negatively affect native species in the future. Winter freezes currently limit many forest pests, but higher temperatures will likely allow these species to increase. Destructive insects, such as southern pine beetles, will be better able to take advantage of forests due to factors such as increased drought. Certain invasive plant species found in this forest, including kudzu and Japanese honeysuckle are expected to increase dramatically as they are able to tolerate a wide range of harsh conditions, allowing them to rapidly move into new areas.

Response: Manage tree densities through practices such as thinning and prescribed fire to maximize carbon sequestration and reduce the vulnerability of forest stands to water stress, insect and disease outbreaks, and fire.

Response: Continually monitor for new invasive species moving into areas where they were not traditionally found, especially following events such as hurricanes and fire.

Japanese Honeysuckle

Plant Communities - Heat stress may limit the growth of some southern pines and hardwood species. Stresses from drought and wide-scale pest outbreaks have the potential to cause large areas of forest dieback. Intensified extreme weather events, such as hurricanes, ice storms, and fire, are also expected to lead to changes in plant community composition. Populations of some rare or endemic plants may be disproportionately impacted. Species more resistant to these disturbances, such as longleaf pine, will be more resilient to a changing climate.

Response: Focus restoration efforts in hurricane-resistant forests, such as longleaf pine as well as sweetgum or red oak hardwood, and promote the planting of longleaf pines over loblolly pine where feasible.

Response: Include a range of ages and species in forests to lessen potential loss from drought or infestation.

Longleaf pine

Animal Communities - Wildlife species will be affected in different ways. Amphibians may be most at risk, due to dependencies on moisture and cool temperatures that could be altered. Bird species, such as red cockaded woodpeckers, may see a decrease in population as vegetation types change and heat stress makes food more difficult to come by. Alternatively, mammals such as deer and bears may increase due to higher survival rates during warmer winters.

Red-Cockaded Woodpecker

Response: Maintain piles of natural woody debris in areas of high amphibian diversity to supplement habitats that retain cool, moist conditions.

Response: Create habitat corridors, assist in species movement, increase National Forest management unit sizes, and identify high-value conservation lands adjacent to National Forests.

Extreme Weather - The potential for severe storms is expected to increase in the future, including more intense hurricanes making landfall in the southern US. Extended periods of extreme high temperature and drought may lead to drier forest fuels which will burn more easily and contribute to larger and more frequent wildfires. More cloud-to-ground lightning due to warming may also increase wildfire ignitions.

Response: Identify areas that provide particularly valuable ecosystem services, like timber harvest or carbon sequestration, and are also vulnerable to extreme weather, like hurricanes or fires. Then plan conservation strategies accordingly to mitigate for extreme weather impacts and payment for ecosystem service programs.

Response: Prescribed burning can also be a management option for reducing the impacts of any future increases in wildfire potential emanating from climate change.

Water Resources - Shifts in rainfall patterns will lead to periods of flooding and drought that can significantly impact water resources. Increases in heavy downpours and more intense hurricanes can lead to greater erosion and more sedimentation in waterways. Increased periods of drought may lead to poor water quality.

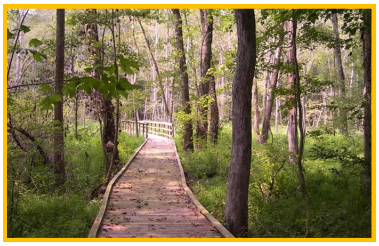
Response: Focus attention on and near smaller, isolated water systems that are more vulnerable and may not be able to absorb and benefit from wildfires and heavy rains that cause large floods or debris flow.

Response: Restore and reinforce vegetation in headwater and marsh areas to help alleviate runoff of sediment during heavy rain, reduce climate-induced warming of water, and decrease water sensitivity to changes in air temperature.

Recreation - Environmental changes may negatively impact recreational experiences due to changes in the plant and animal communities that make those experiences unique. More days above freezing could increase tick and mosquito populations throughout the year, leading to an increase in vector-borne illness. With more days of extreme heat, recreation areas could see decreased use in the summer if temperatures impact visitor comfort.

Response: Examine the goals for a water system or area of land when considering changing dynamics. For example, a stream managed mostly for recreation must balance the demand for rainbow trout from anglers with other aquatic and terrestrial impacts.

Response: Communicate early warnings for extreme weather to protect vulnerable groups from health impacts, such as heat illnesses, and monitor for early outbreaks of disease.



Boardwalk

Waterfall

Mountain biking

Climate Change and Your National Forest: Citations

Information in this factsheet is summarized from 54 peer-reviewed science papers found in the USDA Forest Service's TACCIMO tool. TACCIMO (the Template for Assessing Climate Change Impacts and Management Options) is a web-based application integrating climate change science with management and planning options through search and reporting tools that connect land managers with peer-reviewed information they can trust. For more information and the latest science about managing healthy forests for the future visit the TACCIMO tool online: **www.forestthreats.org/taccimotool**

Forest Health

Duerr, D. A., Mistretta, P. A. Invasive Pests – Insects and Diseases (2013) In, Wear, D. N., Greis, J. G., eds. The Southern Forest Futures Project. General Technical Report SRS-GTR-178. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Gan, J. (2004). Risk and damage of southern pine beetle outbreaks under global climate change. Forest Ecology and Management, 191, 61–71. doi:10.1016/j.foreco.2003.11.001

Funk, J. L., Cleland, E. E., Suding, K. N., & Zavaleta, E. S. (2008). Restoration through reassembly: plant traits and invasion resistance. Trends in Ecology & Evolution, 23(12), 695-703. doi:10.1016/j.tree.2008.07.013

Greenberg, C. H., Perry, R. W., Franzreb, K. E., Loeb, S. C., Saenz, D., Rudolph, D. C., & Tanner, G. W. (2013). Climate Change and Wildlife in the Southern United States. In: Vose, J. M., Klepzig, K. D., eds. Climate change adaptation and mitigation management options: A guide for natural resource managers in southern forest ecosystems. Boca Raton, FL: CRC Press. 379-420

Jianbang, G. (2004). Risk and damage of southern pine beetle outbreaks under global climate change. Forest Ecology and Management, 191, 61-71.

Miller, J. H., Lemke, D., Couston, J. The Invasion of Southern Forests by Nonnative Plants: Current and Future Occupation, with Impacts, Management Strategies, and Mitigation Approaches (2013) In, Wear, D. N., Greis, J. G., eds. The Southern Forest Futures Project. General Technical Report SRS-GTR-178. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Sasek, T. W., & Strain, B. R. (1990). Implications of atmospheric CO2 enrichment and climatic change for the geographical distribution of two introduced vines in the USA. Climatic Change, 16(1), 31-51.

Plant Communities

Bernazzani, P., Bradley, B., and Opperman, J. (2012). Integrating climate change into habitat conservation plans under the U.S. Endangered Species Act. Environmental Management, 49(6), 1103-1114. doi:10.1007/s00267-012-9853-2.

Duehl, A. J., Koch, F. H., & Hain, F. P. (2011). Southern pine beetle regional outbreaks modeled on landscape, climate and infestation history. Forest Ecology and Management, 261(3), 473 -479. doi:10.1016/j.foreco.2010.10.032

Hansen, A. J., Neilson, R. P., Dale, V. H., Flather, C. H., Iverson, L. R., Currie, D. J., Bartlein, P. J. (2001). Global change in forests: Responses of species, communities, and biomes. BioScience, 51, 765-779.

Hellmann, J. J., Byers, J. E., Bierwagen, B. G., & Dukes, J. S. (2008). Five potential consequences of climate change for invasive species. Conservation Biology, 22(3), 534-543.

McNulty, S. G. (2002). Hurricane impacts on us forest carbon sequestration. Environmental Pollution, 116, 817-824. doi:10.1016/S0269-7491(01)00242-1.

Animal Communities

Ayres, M. P. & Lombardero, M. J. (2000). Assessing the consequences of global change for forest disturbance from herbivores and pathogens. The Science of the Total Environment, 262, 263-286.

Blaustein, A. R., Walls, S. C., Bancroft, B. A., Lawler, J. J., Searle, C. L., & Gervasi, S. S. (2010). Direct and indirect effects of climate change on amphibian populations. Diversity, 2(2), 281-313. doi:10.3390/d2020281

Corn, P. S. (2005). Climate change and amphibians. Animal Biodiversity and Conservation, 28, (1), 59 - 67.

Currie, D. J. (2001). Projected Effects of Climate Change on Patterns of Vertebrate and Tree Species Richness in the Conterminous United States. Ecosystems, 4, 216-225. doi: 10.1007/s10021–001–0005-4

Joyce, L. A., Blate, G. M., Littell, J. S., McNulty, S. G., Millar, C. I., Moser, S. C., Peterson, D. L. (2008). National forests. in: Preliminary review of adaptation options for climate-sensitive ecosystems and resources. a report by the U.S. climate change science program and the subcommittee on global change research. U.S. Environmental Protection Agency, 1-127.

Lawler, J. J. & Olden, J. D. (2011). Reframing the debate over assisted colonization. Frontiers in Ecology and the Environment, doi:10.1890/100106

Matthews, S. N., O'Connor, R. J., Iverson, L. R., & Prasad, A. M. (2004). Atlas of climate change effects in 150 bird species of the Eastern United States (General Technical Report NE-318). Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 1-46.

Shoo, L. P., Olson, D. H., McMenamin, S. K. Murray, K. A. Van Sluys, M., Herbert, S. M., Bishopm, P. J., … & Hero, J. –M. (2011). Engineering a future for amphibians under climate change. Journal of Applied Ecology, 48, 487-492. doi: 10.1111/j.1365-2664.2010.01942.x

Torti, V. M. & Dunn, P. O. (2005). Variable effects of climate change on six species of North American birds. Oecologia, 145, 486 – 495.

Extreme Weather

Delphin, S., Escobedo, F. J., Abd-Elrahman, A., & Cropper Jr, W. (2013). Mapping potential carbon and timber losses from hurricanes using a decision tree and ecosystem services driver model. Journal of Environmental Management, 129, 599-607.

Flannigan, M. D., Stocks, B. J., & Wotton, B. M. (2000). Climate change and forest fires. Science of the Total Environment, 262, 221-229. http://dx.doi.org/10.1016/S0048-9697(00)00524-6

Heilman, W. E., Potter, B. E., & Zerbe, J. I. (1998). Regional climate change in the southern united states: The implications for wildfire occurrence. Productivity & Sustainability of Southern Forest Ecosystems in a Changing Environment, 1, 683-699.

Knutson, T. R., McBride, J. L., Chan, J., Emanuel, K., Holland, G., Landsea, C., Held, I., Kossin, J. P., Srivastava, A. K., & Sugi, M. (2010). Tropical cyclones and climate change. Nature Geoscience, 3(3), 157-163. doi:10.1038/ngeo779

Liu, Y., Prestemon, J. P., Goodrick, S. L., Holmes, T. P., Stanturf, J. A., Vose, J. M., Sun, G. (2014) Future wildfire trends, impacts,

and mitigation options in the Southern United States. In: Vose, J. M., Klepzig, K. D., eds. Climate change adaptation and mitigation management options: A guide for natural resource managers in southern forest ecosystems. Boca Raton, FL: CRC Press. 85-126.
Seneviratne, S. I., Nicholls, N., Easterling, D., Goodess, C.M., Kanae, S., Kossin, J., … & Zhang, X. (2012). Changes in climate extremes and their impacts on the natural physical environment. In: Field, C.B et al. (Eds.), Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge, UK, and New York, NY, USA: Cambridge University Press, 109-230.

Water Resources

Carpenter, S. R., Fisher, S. G., Grimm, N. B., & Kitchell, J. F. (1992). Global change and freshwater ecosystems. Annual Review Ecological Systems, 119-139.
Erwin, K. L. (2009). Wetlands and global climate change: the role of wetland restoration in a changing world. Wetlands Ecology and Management, 17(1), 71-84. doi:10.1007/s11273-008-9119-1
Karl, T. R., Melillo, J. M., & Peterson, T. C. (2009). Global climate change impacts in the United States. New York, NY, USA: Cambridge University Press.
McDonnell, T. C., Sloat, M. R., Sullivan, T. J., Dolloff, C. A., Hessburg, P. F., Povak, N. A., ... & Sams, C. (2015). Downstream Warming and Headwater Acidity May Diminish Coldwater Habitat in Southern Appalachian Mountain Streams. PloS one, 10 (8), e0134757.
Rieman, B. E., Hessburg, P. F., Luce, C., & Dare, M. R. (2010). Wildfire and management of forests and native fishes: Conflict or opportunity for convergent solutions? BioScience, 60 (6), 460-468.
Seager, R., Tzanova, A., & Nakamura, J. (2009). Drought in the Southeastern United States: Causes, variability over the last millennium, and the potential for future hydroclimate change. American Meteorological Society, 22(19), 5021-5045.
Stroh, C. L., De Steven, D., Guntenspergen, G. R. (2008). Effect of climate fluctuations on long-term vegetation dynamics in Carolina bay wetlands. Wetlands, 28(1), 17-27. doi: 10.1672/06-117.1
Wisser, D., Frolking, S., Hagen, S. & Bierkens, M. F. P. (2013). Beyond peak reservoir storage? A global estimate of declining water storage capacity in large reservoirs. Water Resources Research, 49, 5732 – 5739. doi:10.1002/wrcr.20452.

Recreation

Irland, L. C., Adams, D., Alig, R., Betz, C. J., Chen, C., Hutchins, M., & Sohngen, B.L. (2001). Assessing Socioeconomic Impacts of Climate Change on US Forests, Wood-Product Markets, and Forest Recreation. BioScience, 51(9), 753-764. doi: 10.1641/0006-3568(2001)051[0753:ASIOCC]2.0.CO;2
Joyce, L. A., Blate, G. M., Littell, J. S., McNulty, S. G., Millar, C. I., Moser, S. C., Peterson, D. L. (2008). National forests. in: Preliminary review of adaptation options for climate-sensitive ecosystems and resources. a report by the U.S. climate change science program and the subcommittee on global change research. U.S.Environmental Protection Agency, 1-127.
Luber, G., K. Knowlton, J. Balbus, H. Frumkin, M. Hayden, J. Hess, M. McGeehin, N. Sheats, L. Backer, C. B. Beard, K. L. Ebi, E. Maibach, R. S. Ostfeld, C. Wiedinmyer, E. Zielinski-Gutiérrez, & L. Ziska, (2014). Ch. 9: Human Health. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 220-256.
Najjar, R. G., Walker, H. A., Anderson, P. J., Barron, E. J., Bord, R. J., Gibson, J. R., Kennedy, V. S., … & Swanson, R. S. (2000). The potential impacts of climate change on the mid-Atlantic coastal region. Climate Research, 14, 219-233.
Richardson, R. B., Loomis, J. B. (2004). Adaptive recreation planning and climate change: a contingent visitation approach. Ecological Economics, 50, 83-99. doi:10.1016/j.ecolecon.2004.02.010
Scott, D., McBoyle, G., & Schwartzentruber, M. (2004). Climate change and the distribution of climatic resources for tourism in North America. Climate Research, 105-117.